Eaton, A. J.
1936

How much time is needed to take an average fifth or sixth grade pupil from inaccuracy to 100% accuracy in a fundamental process of arithmetic --- Multiplication for example.

Boston University

School of Education

Thesis

How Much Time is Needed to Take an Average Fifth or Sixth Grade Pupil from Inaccuracy to 100 % Accuracy in a Fundamental Process of Arithmetic,--Multiplication for Example

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B.S. in Ed. Boston University 1934

In partial fulfillment of the requirements

for the degree of Master of Education.

1936

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Sept 17 1836
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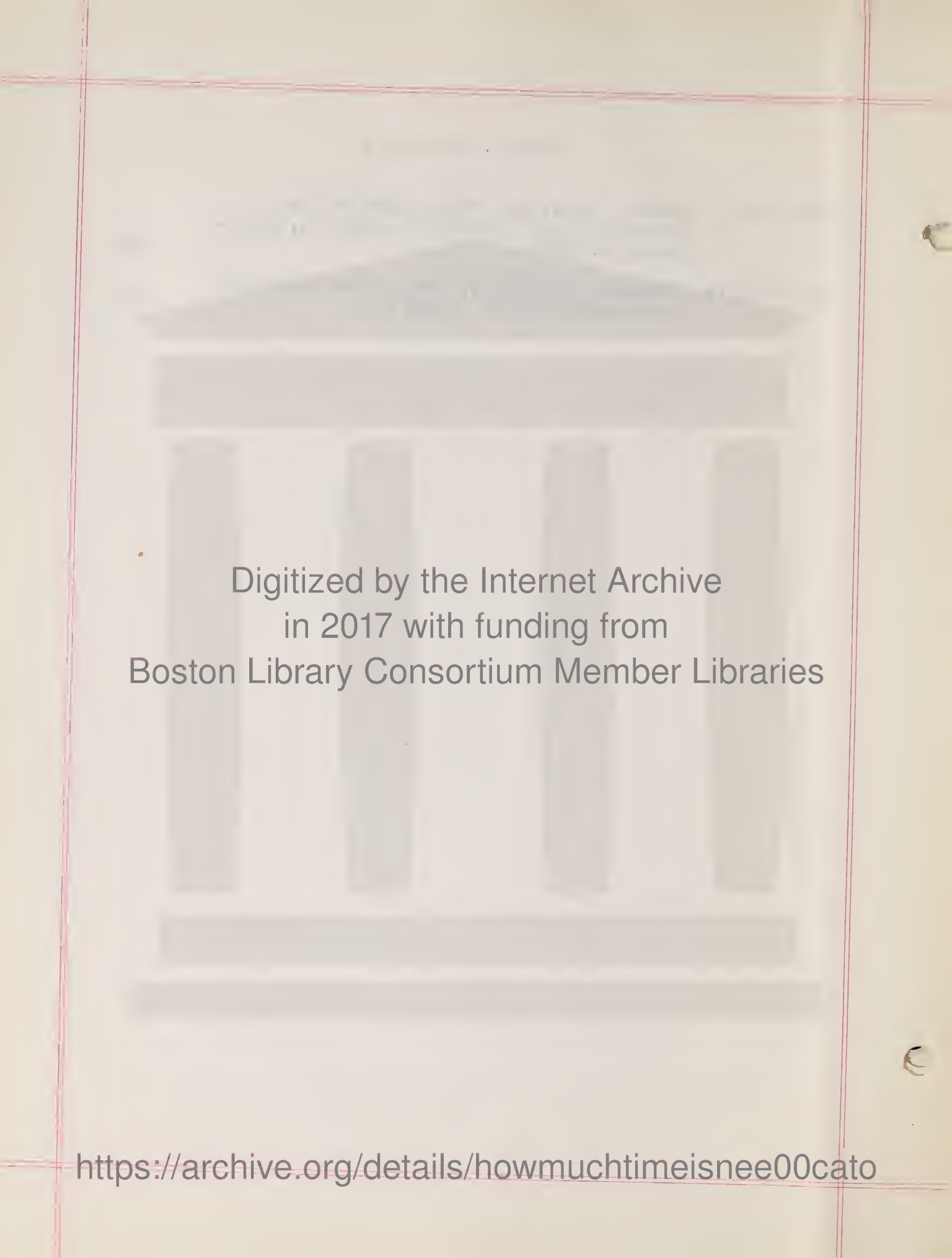


GRAPHS

HOW MUCH TIME IS NEEDED TO TAKE AN AVERAGE FIFTH OR SIXTH GRADE PUPIL FROM INACCURACY TO 100% ACCURACY IN A FUNDAMENTAL PROCESS OF ARITHMETIC, MULTIPLICATION, FOR EXAMPLE?

Chapter I. Introduction

Problem:

How Much Time is Needed to Take an Average Fifth or Sixth Grade Pupil from Inaccuracy to 100% Accuracy in a Fundamental Process of Arithmetic,-Multiplication, for Example?

Method.

An attempt will be made to diagnose types of errors in multiplication and to furnish remedial measures necessary to attain 100% accuracy in one fifth and one sixth grade. Part of the study will be devoted to the "Time" element from the standpoint of accuracy and not from the standpoint of speed. If some children are given time enough they might do their work accurately by reverting to the counting habit or "saying the tables." Gary Cleveland Myers refers to this method as the "pernicious counting habit." Even then we find many inaccuracies. Automatic response to the multiplication combinations is the most necessary factor in attaining perfect mastery. Increase in time, therefore, becomes a danger signal and indicates the need of specific checking on habits of work.

In order to secure this the Wilson 5 P Test in Multiplication was given to one fifth grade class and one sixth grade class of average ability. Specific remedial work was

given to those pupils who did not receive a perfect score. Their "Time" was noted for habits of work. Twenty-minute periods of specific remedial work were given. The pupils were tested at intervals, the time required to do the test was recorded, and the number of periods of specific remedial work necessary for the pupil to obtain a perfect score were noted. Each pupil receiving a perfect score on a re-test was excused from further drill. The "Time" recorded included checking in all cases.

Historical Background

Many changes in the teaching of arithmetic have occurred since 1900. Before that time, arithmetic, with all of its difficulties, was taken for granted. The more difficult the problem or the more intricate the process, the more discipline it gave for later life; such was the theory.

Arithmetic was placed in the curriculum in this country as early as 1750 because of the necessity of teaching computation in the development of industry. Gradually the time devoted to arithmetic was extended. During the first half of the next century the boys in many rural and small town schools devoted fully half of their time to arithmetic.

In an unpublished thesis entitled "Five Case Studies of Arithmetic Failure" Boston University School of Education, 1935, by R.F. Pucko, (36) the historical development of arithmetic is summarized. Further comments would be repetition.

(36) See Bibliography.

Chapter II

Preliminary Study.

A preliminary study of errors in multiplication was made in February, 1934. Dr. Wilson's 5 P Multiplication test was given in a city system in Grades, five, six and seven in February, 1934, and in Grade four in May, 1934. Twenty-six types or errors were noted and tabulated.

One error in each incorrect example was found in Grade Four due to the fact that the work in multiplication was "fresh" in their minds. In Grades Five and Six some of the incorrect examples contained more than one error due probably to carelessness as the errors were inconsistent. In Grade Seven each incorrect example contained one error.

Total number of pupils tested			735
(2 classes)	Grade IV	65	
(2 ½ classes)	Grade V	93	
(2 ½ classes)	Grade VI	100	
(14 classes)	Grade VII	477	
		735	

No. of examples		No. of incorrect examples	No. of errors
IV	1625	477	477
V	2325	533	570
VI	2500	455	513
VII	11925	1509	1509

Table 1 on page 5 provides a summary and a comparison of percentage of errors in Grades Four to Seven inclusive, in this preliminary study. "Carrying in multiplication" received the highest percentage of errors in all grades. For the four grades combined it equalled 20.85%.

"Omitted one product" received the second highest percentage of errors in Grade Four--12.99%. In Grade Five the second highest percentage of errors occurred in "adding the partial products."--16.31%, while in Grade Six the second highest percentage of errors was found when "the first figure or the first two figures in the multiplier were a zero or zeros--17.73%. In Grade Seven the second highest percentage of errors occurred, as in Grade Six, when "the first figure or the first two figures in the multiplier were a zero or zeros--19.54%.

"Errors in adding the partial products" ranked third in Grades Four, Six, and Seven; Grade Four--12.15%; Grade Six--17.53%; Grade Seven--12.65%. In Grade Five "the first figure or the first two figures in the multiplier a zero or zeros" ranked third--15.26%.

"Multiplied incorrectly--no carrying" came fourth in Grades Five, Six, and Seven; Grade Five--8.94%; Grade Six--7.21%; Grade Seven--12.37%. The fourth percentage of errors in Grade Four occurred when "the first figure or the first two figures of the multiplier were a zero or zeros--12.15%.

Number Five in percentage of errors in Grade Four occurred in "multiplying incorrectly--no carrying"--8.38%; in Grade Five "omitted one partial product"--8.59%; in Grade Six "put in a decimal point"--5.06%; in Grade Seven "omitted a dollars sign"--3.84%.

Number Six in percentage of errors in Grade Four-"the partial product in the wrong place"--6.70%; in Grade Five-"put in a decimal point"--4.83%; Grade Six-"zero times digit"--4.67%; Grade Seven "multiplied the partial products instead of adding them"--3.65%.

Number seven in percentage of errors in Grade Four-"multiplied the partial products instead of adding them"--5.03%; Grade Five "omitted the dollars sign"--3.33%; Grade Six-"omitted the dollars sign"--4.09%; Grade seven-"omitted one partial product"--3.04%.

Number eight in percentage of errors in Grade Four-"digit times zero"--3.14%; Grade Five-"zero times digit"--3.15%; Grade six--"digit times zero"--4.09%; Grade Seven-"Zero times digit"--2.31%.

It is evident from Table 1 that carrying, zero difficulties, and adding partial products are major causes of difficulty in multiplication. Together they account for 49.98% of the errors of the 735 pupils in Grades Four, Five, Six, and Seven who took the Wilson 5 P Multiplication Test in February and May, 1934. In Tables 11, 111, IV, and V, respectively, the eight most frequent errors for each grade are shown.

In each grade carrying stands at the top of the list, as a cause of error.

Table 1

Showing the Types of Errors in the Preliminary Study in Grades Four, Five, Six, and Seven, as shown by the returns in the 5 P Multiplication Test Feb, 12, 1934; Feb. 19, 1934; May 19, 1934

	Gr.IV 65	Gr. V 93	Gr. VI 100	Gr.VII 477
1 Multiplied wrong-no carrying	40	51	37	187
2 Carrying in multiplication	120	112	136	472
3 Added instead of multiplying	1	10	2	26
4 Errors in adding products	58	93	90	191
5 Did not add the products	7	6	2	6
6 Dollars and cents times ten	12	16	11	11
7 Omitted dollars sign	0	19	21	58
8 Omitted decimal point	0	8	8	10
9 Omitted dollars sign and decimal point in same example	6	4	10	31
10 Put in a decimal point	5	25	26	8
11 Decimal point in wrong place	1	5	4	16
12 Zero times digit	7	18	24	35
13 Digit times zero	15	9	21	21
14 Zero in multiplicand	5	12	3	9
15 Zero in multiplicand and multiplier	0	2	1	7
16 Omitted one product	62	49	14	46
17 Did not multiply last figure in multiplicand	2	3	0	3
18 Multiplied last figure in multiplicand twice	2	1	2	0
19 Put in extra figure in the answer or in the products	6	2	4	2
20 Left out one figure in the product 9 x 4--3(6) omitting the 6	10	3	1	1
21 Omitted the example	1	11	0	11
22 Began with second figure in multiplicand for the second product	2	8	0	1
23 Product in the wrong place	32	13	4	2
24 Errow when first figure or first two figures in multiplier-zero or zeros	58	87	91	295

Table 1 (continued)

	Gr. IV	Gr. V	Gr. VI	Gr. VII
	65	93	100	477
25 Multiplied instead of adding the products	24	3	0	55
26 Omitted a figure in the multiplicand not otherwise covered	1	0	2	5
Total number of errors	477	570	513	1509

Table 11

Showing Eight of the Most Frequent Errors and the Percentage of Errors in Grade Four as shown by the Analysis of the 5P Multiplication Test, May 17, 1934

1	Carrying in multiplication	120	25.15 %
2	Omitted one product	62	12.99 %
3	Errors in adding the products	58	12.15 %
4	Errors when first figure or first two figures in multiplier--zero or zeros	58	12.15 %
5	Multiplied incorrectly--no carrying	40	8.38 %
6	Product in the wrong place	32	6.70 %
7	Multiplied instead of adding the products	24	5.03 %
8	Digit times Zero	15	3.14 %

Total of the eight most frequent errors	409
Total number of errors	477
Total number of pupils (two classes)	65

The above table is read as follows:

Carrying in multiplication ranked first in the types of errors.

There were 120 errors of this type.

Tables III, IV, and V are read in the same manner.

Table III

Showing Eight of the Most Frequent Errors and the Percentage of Errors in Grade Five as shown by the Analysis of the 5 P Multiplication Test, Feb. 12, 1934

1	Carrying in multiplication	112	19.64 %
2	Errors in adding the products	93	16.31 %
3	Error when first figure or first two figures in multiplier-zero or zeros	87	15.26 %
4	Multiplied incorrectly-no carrying	51	8.94 %
5	Omitted one product	49	8.59 %
6	Put in a decimal point	25	4.38%
7	Omitted dollars sign	19	3.33 %
8	Zero times digit	18	3.15 %
	Total of the eight most frequent errors	454	79.64 %
	Total number of errors	570	
	Total number of pupils ($2\frac{1}{2}$ classes)	93	

Table IV

Showing Eight of the Most Frequent Errors and the Percentage of Errors in Grade Six as shown by the Analysis of the 5 P Multiplication Test. Feb. 12, 1934

1	Carrying in multiplication	136	26.51 %
2	Error when first figure or first two figures in multiplier-zero or zeros	91	17.73 %
3	Errors in adding the product	90	17.54 %
4	Multiplied incorrectly--no carrying	37	7.21 %
5	Put in a decimal point	26	5.06 %
6	Zero times digit	24	4.67 %
7	Omitted dollars sign	21	4.09 %
8	Digit times zero	21	4.09 %
	Total of the eight most frequent errors	446	86.93 %
	Total number of errors	513	
	Total number of pupils ($2\frac{1}{2}$ classes)	100	

Table V

Showing Eight of the Most Frequent Errors and the Percentage of Errors in Grade Seven as shown by the Analysis of the 5 P Multiplication Test. Feb. 19, 1934

1	Carrying in multiplication	472	31.27 %
2	Error when first figure or first two figures in multiplier-zero or zeros	295	19.54 %
3	Errors in adding the products	191	12.65 %
4	Multiplied incorrectly--no carrying	187	12.39 %
5	Omitted dollars sign	58	3.84 %
6	Multiplied instead of adding the products	55	3.65 %
7	Omitted one product	46	3.04 %
8	Zero times digit	35	2.31 %
	Total of the eight most frequent errors	1339	88.73 %
	Total number of errors	1509	
	Total number of pupils (14 classes)	477	

In Grade Four there were two perfect scores; in Grade Five there was one perfect score; in Grade Six there was one perfect score; and in Grade seven there were seventy-three perfect scores. In the four grades there were seventy-seven perfect scores equalling 10.99%.

In Table VI will be found the summary of the scores for each of the four grades, and in Table VII will be found the summary of the median, quartile three, quartile one, high score, low score, and standard deviation for each of the grades.

Table VI

Showing Summary of the Scores for Each Grade, in the Preliminary Study in the Spring of 1934

Score	Grade Four	Grade Five	Grade Six	Grade Seven
100	2	1	1	73
96	5	2	14	69
92	3	8	12	68
88	7	16	18	85
84	4	15	14	55
80	13	8	10	35
76	3	13	9	46
72	8	8	8	26
68	3	8	4	6
64	2	2	5	5
60	2	2	1	5
56	1	3	0	1
52	1	3	0	1
48	2	1	1	1
44	3	1	1	0
40	0	1	0	1
36	1	0	1	0
32	1	0	1	0
28	1	0	0	0
24	1	0	0	0
20	1	1	0	0
16	1	0	0	0

The percentage of perfect scores in the four grades was 10.47 %.

The above table is read as follows:

Two pupils in Grade Four, one pupil in Grade Five, one pupil in Grade Six, and seventy-three pupils in Grade Seven received perfect scores.

Table VII

A Point Summary of the Scores for Each Grade in the Preliminary Study in the Spring of 1934

	High	Q-3	Median	Q-1	Low	S.D.
Grade 4	100	88	80	64	16	21.30
Grade 5	100	88	80	72	20	13.52
Grade 6	100	92	84	76	32	12.63
Grade 7	100	92	88	80	40	9.96

The above table is read as follows:

In Grade Four the median score was 80; third quartile 88; first quartile 64; high score 100; low score 16; standard deviation 21.30.

Chapter III

The Zero Difficulty

The "zero difficulty" is discussed briefly here as an illustration of the difficulties which confront us in multiplication. Some children have no difficulty with the digit times zero but do have difficulty with the zero times the digit. On the other hand some children have no difficulty with the zero times the digit but do have trouble with the digit times the zero. Others have difficulty with both.

The "zero difficulty" and "carrying in multiplication" are the two types of errors most commonly reported upon by workers in research on multiplication difficulties. Here are three comments by research students:

"The zero is one of the greatest arithmetic trouble makers in the elementary school." (22)

"Children who are learning arithmetic must actually employ the zero for what it is intended--a place holder." (44)

"The most common fault in multiplication is lack of knowledge of the basic combinations especially those in which the zero is involved. This fault is also revealed by the pupils who count or repeat the tables to procure the product.

Another source of error in multiplication is faulty carrying, thereby revealing a weakness in addition.

Numerous faulty procedures are found in examples involving the work of multiplying by two or more figures especially when the multiplier contains one or more zeros.

The analysis of the data concerning faulty procedures suggests the following:

(1) The necessity of giving special attention to examples involving zeros in either multiplicand or multiplier.

(2) The necessity of insisting on neat work and the correct placing of partial products.

(3) The desirability of requiring the pupil to recheck the entire work before being prepared to accept the answer as correct." (7)

There is practically no variation in the types of errors in multiplication in the different research studies which were examined by the writer. During the first semester of 1924-1925 a test containing 210 examples in multiplication was given to two thousand pupils in Grades Four B to Eight A inclusive in twelve schools in the city of Milwaukee, Wisconsin. The findings were as follows:

"(1) Specific drill during special help time for two weeks reduced the errors from 7.6 in the first test to 0.8 in the third test.

(2) There proved to be several 'zero' difficulties instead of one as is commonly accepted. The per cent of errors in examples with zeros in the units place was found to be almost always greater than in examples with zeros in the tens place.

(3) Certain types of errors especially where the zero occurred in the units place persisted even though specific drill was given.

(4) The greatest source of error in carrying occurred when the sum of the carried number and the partial product was in a decade above the partial product as in the following example:

888
X7
7216 16 added instead of 6

(5) Drill upon specific skills in which pupils were weak yielded larger returns than indescriminate drills.

(6) The diagnostic tests revealed the weak skills, while drill cards enabled the teachers to give specific drill upon the specific weaknesses of each pupil.

(7) That forgetting played an important part was proved by the fact that the per cent of error increased from 0.8 in test 3 to 1.4 in test 4. The time between test 3 and test 4 was three months, during which no specific drill was given." (12)

Drill

Since multiplication is so closely allied to addition it will be necessary for the pupil to meet the addition requirements:

"The 100 primary or first decade facts.
The 300 upper decade facts through 399.
The 80 additional higher facts needed for carrying in multiplication through 9 X 9." (49)

These added to the 100 multiplication combinations through 9 X 9 complete the requirements for 100 per cent mastery as far as the multiplication facts are concerned. Beyond the facts are the process difficulties, and these must be mastered also.

Can the school child be given complete control of the fundamentals in school life? This study tends to prove that it can if the load is properly reduced and the material well organized.

"More attention should be directed toward a definite attempt to secure 100 per cent accuracy in arithmetic. With correctly chosen subject matter and a well organized teaching program the average child becomes perfect in the ground work of the fundamentals.

Reasons for failure in the past:

1. More than half of the time has been spent on useless processes, processes never used by the adult community and therefore not likely to be used outside of the schoolroom by the pupils.
2. Beginning formal drill too early.
3. Absence of adequate teaching plans. There has been no plan for teaching facts in sizable units and there has been no plan for checking.
4. Lack of adequate drill service.

In the attempt to gain 100 per cent results in arithmetic the first step is the proper choice of subject matter. 95 per cent of all arithmetic used in all occupations consists of simple manipulations in the four fundamentals." (57)

The Twenty Ninth Yearbook of the National Society for the Study of Education gives the following aspects of modern thought on arithmetic:

"We drill to build a skill and we drill to maintain a skill.

Drill and application should follow effective learning of the content.

Instruction and drill should be interspersed.

The intention to learn should be dominant, not for the moment, but permanently.

Clear well-understood ideas of a process should be grasped before drilling upon it.

Careful construction of drill should be built so that certain combinations are not forever begbears to the child.

The work should be presented in such varities of situations that the child is not lost the moment the problem is situated in a way to which he is not accustomed.

There should be genuine motivation of effort.

Careful testing should reveal the weak points followed by prudent re-teaching and drill before such weak points become chronic.

There should be a judicious grading of work to varying abilities." (24)

Drill cannot be effective unless the causes of the types of errors can be discovered and corrected by application of the particular instruction which the individual pupil needs. Such instruction will correct the erroneous methods of procedure; group instruction is not enough.

Greene and Buswell in their article on "Testing, Diagnosis, and Remedial Work" in the Twenty-Ninth Yearbook of the National Society for the Study of Education (18) make the following statements:

"Group diagnostic testing should always come first.

Individual diagnosis testing follows with the further analysis of the particular difficulties which the pupil experiences in order that his method of working may be made more effective.

The chief purpose of individual diagnosis is to discover how the pupil works when he proceeds in his regular manner.

Diagnostic procedure and remedial procedure should be separate processes and the teacher should not attempt to remedy a poor method while making a diagnosis.

Real teaching must be individual teaching to a very considerable extent.

Effective teaching is specific teaching.

Careful individual diagnosis must be made in the case of children who have serious difficulties.

It is a mistake to give all pupils the same drill. It is a waste of time for those who do not need the drill.

The basic principles underlying individual diagnostic and remedial work is that improvement in the results obtained will be sought by an improvement in the methods by which these results are obtained." (18)

Remedial work provides for individual differences. It not only furnishes corrective work for the pupil who is slow but it also provides enrichment for the pupil who is able to proceed at a more rapid rate. It should also eliminate that which is not practical or useful in arithmetic. In this manner the load will be lightened and the joy of accomplishment can be experienced by every pupil of normal intelligence.

"Suit the amount of drill to the difficulty of the task.

Teach that which is most used in life.

Teach that which the pupils do not know.

Do not try to teach what the child could not learn even with the best teacher in the world.

Always do your best to encourage pupils to want to learn what they should learn.

Teach what is most used or should be most used in life." (32)

In summary, the aims are about as follows:-

Drill material should be suited to the every day needs of the pupils and useless material eliminated.

Drill material should be suited to the individual needs of the pupils.

Drill must be specific.

Drill should be well organized.

Drill should follow learning.

Drill to build a skill.

Drill to maintain a skill.

Perfect mastery of the four fundamentals must come through understanding followed by automatic response.

Chapter V

Specific Remedial Work in Grade Five and the Results

From the Preliminary Study previously reported in Chapter 1 the writer reached the conclusion that any child of normal intelligence above the fourth grade can attain 100 per cent mastery in multiplication if the load is properly reduced and the material well organized.

On Nov. 5, 1935 the Wilson 5 P Multiplication Test was given to 38 fifth grade pupils ranging in mental ability from 67 I.Q. to 145 I.Q. The I.Q's were determined by the National Intelligence Tests given earlier in the year.

Distribution of I.Q.'s

No. of puplis	I.Q.	No. of pupils	I.Q.
1	67	1	108
1	78	1	110
1	83	1	111
1	86	2	113
2	87	1	114
1	89	3	115
1	93	1	116
1	99	1	118
2	100	2	121
1	101	1	122
1	104	1	131
3	105	1	132
1	106	2	133
2	107	1	145
	Total	38	

From the distribution of the I.Q's this does not seem like an average class. An explanation later in the study accounts for some of the low I.Q.'s.

Table VIII

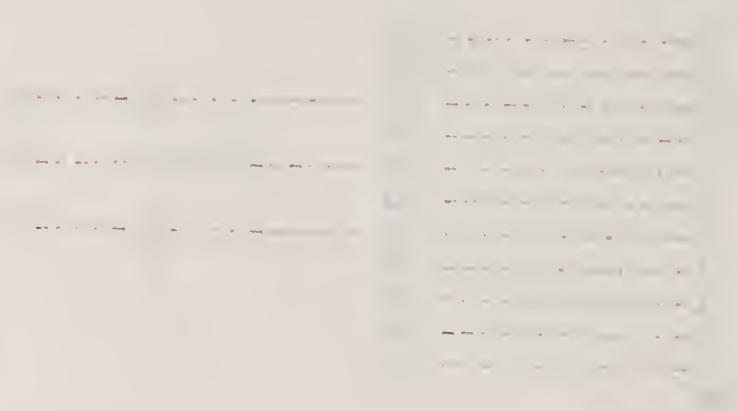
Showing Scores made on the 5 P Multiplication Test by 38 Fifth Grade Pupils, Nov. 5, 1935.

No. of pupils	Score	
2	100	
3	96	
10	92	----------Q3-----92
4	88	
6	84	------Median-----84
3	80	
3	76	----------Q1-----76
4	72	
1	68	
1	64	
1	28	
38		

Showing The Time taken by 38 pupils of the Fifth Grade on the 5 P Multiplication Test: Nov. 5, 1935.

No. of pupils	Time	
1	13	
6	18	
8	19	----------Q3-----19
2	20	
3	22	------Median-----22
5	23	
2	24	
2	25	
2	27	----------Q1-----27
1	29	
1	30	
1	31	
1	32	
1	34	
1	37	
1	40	
38		

The above data on scores and time is shown graphically in Figures 1 and 2 which follow.



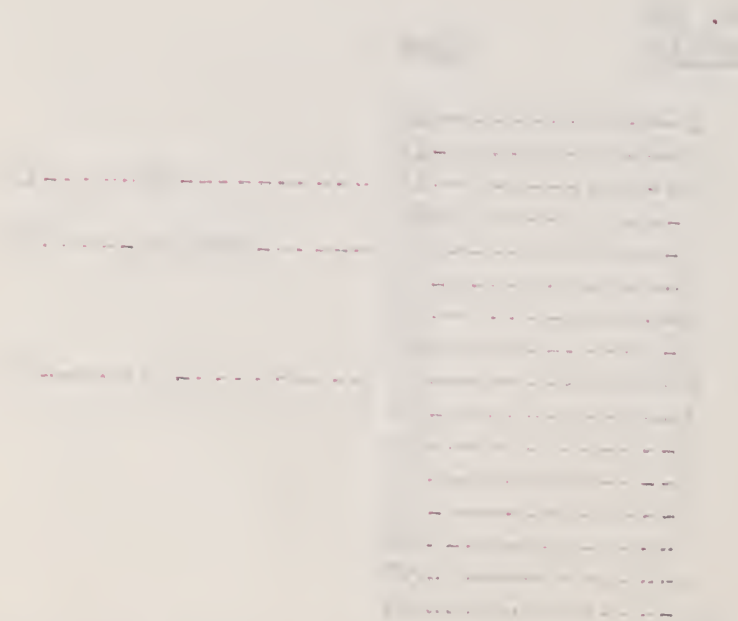


Figure 1

Showing graphically the distribution of scores on the 5 P Multiplication Test made by 38 Fifth Grade pupils

Nov. 5, 1935

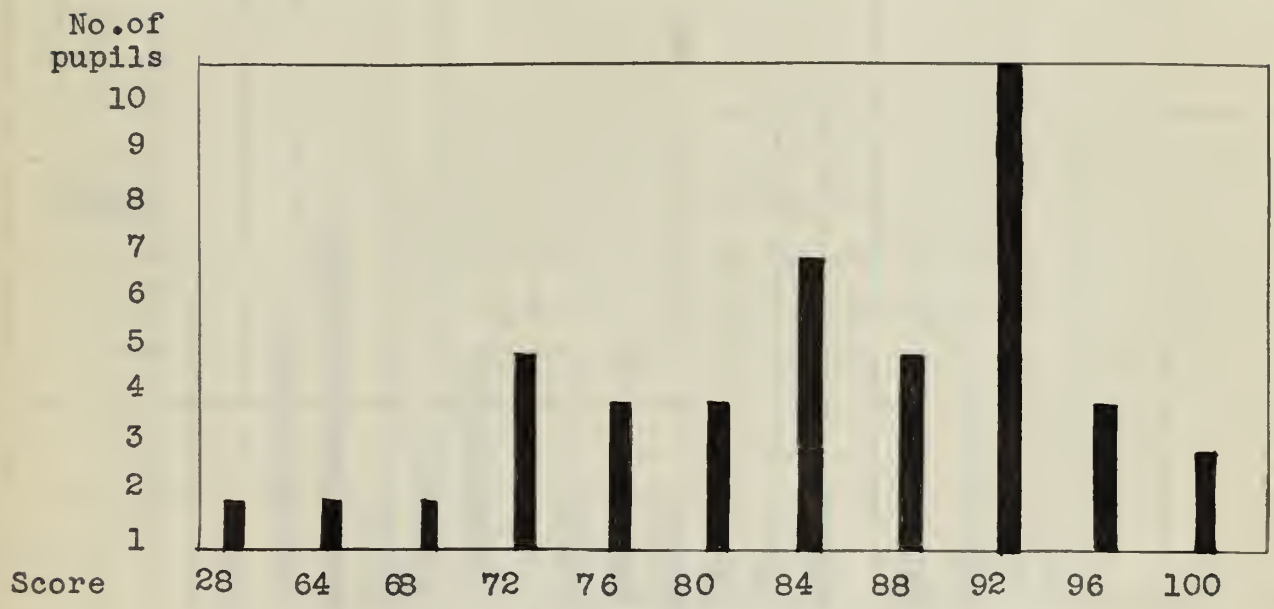


Figure 1 is read as follows:

2 pupils received a score of 100.

Figure 2

Showing graphically the distribution of time in the

5 P Multiplication Test made by 38 Fifth Grade pupils

Nov. 5, 1935

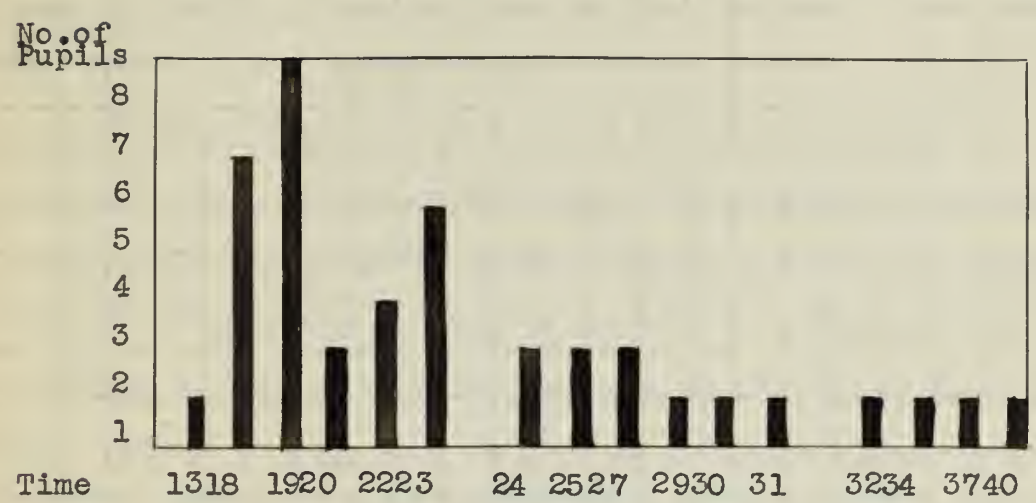


Figure 2 is read as follows:

1 pupil completed the test in 13 minutes.

All time included checking.

Eighteen types of errors were found in the 5 P Multiplication Test done by the 38 fifth grade pupils on Nov. 5, 1935. This was a gain of seven types of errors over the same test given to fifth grade pupils on Feb. 12, 1934.

"Carrying in multiplication" still seems to be the "bugbear." There were 57 errors of this type with a percentage of 36.37. "Omitted one partial product" came second with 16 errors and a percentage of 10.32. Third--"errors in adding the partial products"--14--9.03 %; fourth--"product in the wrong place"--10--6.45 %; fifth--"multiplied incorrectly--no carrying"--10--6.45 %; sixth--"added the partial products instead of multiplying them"--9--5.80 %; seventh--"multiplied instead of adding"--9--9.80%; eighth--"dollars and cents times 10" ($5.90 X 10)--5--3.22%; ninth--"zero times digit"--4--2.58%.

The tenth error was "omitted dollars sign and decimal point" with 4 errors--2.58 %; eleventh "multiplied by the wrong figure"--4--2.58 %; twelfth--"put in a decimal point"--3--1.93 %; thirteenth--"omitted a figure in the multiplicand"--3--1.93 %; fourteenth--"omitted dollars sign"--3--1.93 %; fifteenth--"digit times zero"--1--.64 %; sixteenth--"did not add the partial products"--1--.64 %; seventeenth--"put down the wrong figure"--1--.64 %; eighteenth--"subtracted instead of multiplying--1--.64 %.

The total number of errors was 155.

The above data is shown in Table IX which follows, and is shown graphically in Figure 3 following Table IX.

Table IX

Showing the Types, Number, and Percentage of Errors in the 5 P Multiplication Test, made by 38 Fifth Grade Pupils.

Nov. 5, 1935

1	Carrying in multiplication	57	36.77 %
2	Omitted one partial product	16	10.32 %
3	Errors in adding the partial products	14	9.03 %
4	Product in the wrong place	10	6.45 %
5	Multiplied incorrectly--no carrying	10	6.45 %
6	Added instead of multiplying	9	5.80 %
7	Multiplied instead of adding	9	5.80 %
8	Dollars and cents times 10 ($5.90 X 10)	5	3.22 %
9	Zero times digit	4	2.58 %
10	Omitted dollars sign and decimal point	4	2.58 %
11	Multiplied by the wrong figure	4	2.59 %
12	Put in a decimal point	3	1.93 %
13	Omitted a figure in the multiplicand	3	1.93 %
14	Omitted the dollars sign	3	1.93 %
15	Digit times zero	1	.64 %
16	Did not add the products	1	.64 %
17	Put down the wrong figure	1	.64 %
18	Subtracted instead of multiplying	1	.64 %
	Total number of errors	155	

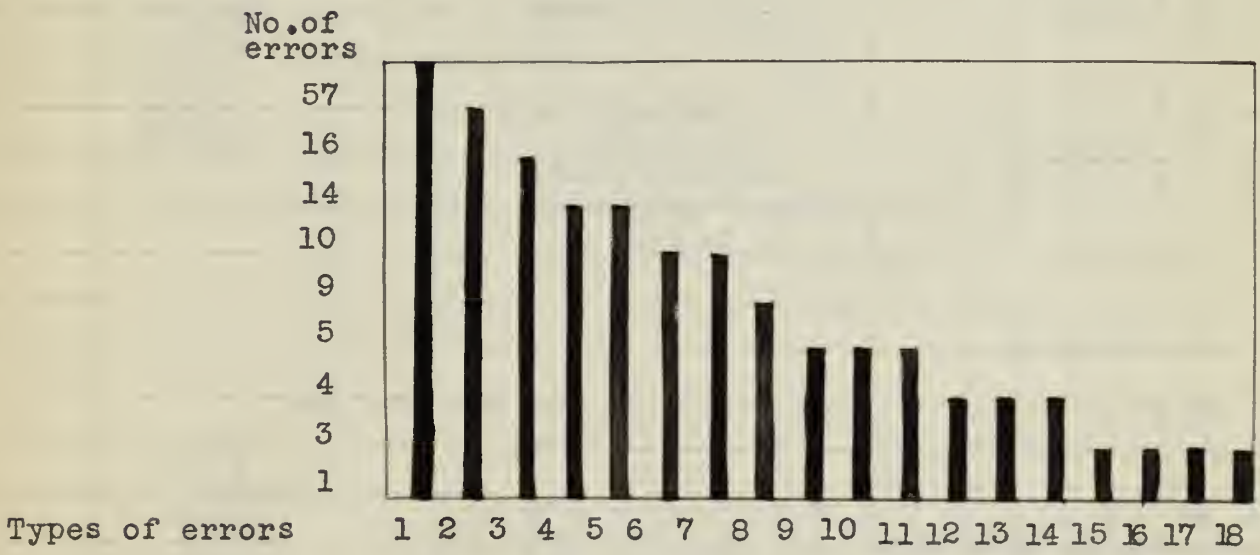
A graph of this table follows.

Figure 3

Showing Graphically the Types of Errors

in the 5 P Multiplication Test Made by 38 Fifth

Grade Pupils Nov. 5, 1935



The 18 types of errors appearing at the bottom of the graph are numbered to correspond with the numbers of the types of errors in Table IX.

Figure 3 is read as follows:

There were 57 errors of type No. 1 (See p. 25)

In Table X which follows, the distribution of the types of errors has been tabulated according to examples. The twenty-five examples are numbered alphabetically from"a"to"y" inclusive. The first seven types of errors which numbered from 9 errors to 57 errors were quite generally distributed from example"h"to y inclusive.

Seven types of errors were found in example"w" as follows:

```
  (w)
  784
X 367
 5488
4704
2352
287728
```

Carrying	12 errors
Omitted one product	4 errors
Error in adding	1 error
Product in wrong place	2 errors
Multiplied incorrectly	2 errors
Added products	2 errors
Multiplied instead of adding	2 errors
	25 errors

Example"w"had the greatest number of errors. There were 11 errors in example"t;" 3 omitted the dollars sign and 3 put in a decimal point; 2 did not multiply by the 1, and one left out one of the figures in the multiplicand.

```
  (t)
$ 680
  120
 13600
 680
$81600
```

One partial product was omitted once in example"b," once in example"i", three times in example"n", twice in example "t"four times in example"v", four times in example"w", and once in example"y". There was one error in adding products in example"k", one in"m", one in"o", 2 in"q", two in"s","t","u", and"v" and one in"w". The other errors were scattering.

Table X

Showing the Distribution of the Types of Errors

by Examples in the 5 P Multiplication Test made by

38 Fifth Grade pupils Nov. 5, 1935

Ex.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
a						1												1	2
b	1	1																	2
c						1													1
d					1														1
e						2			4								1		7
f					2														2
g								5											5
h	3																		3
i	1	1			1		2				1				1				7
j	2						1												3
k	5		1																6
l	3																		3
m	2		1		1														4
n	1	3								4									8
o	5		1													1			7
p	4																		4
q	5		2								1								8
r	4			3		1													8
s	2		2																4
t		2	2									3	1	3					11
u	5		2		1						1		1						10
v	1	4	2	2			2				1								12
w	12	4	1	2	2	2	2												25
x	1	1		2	2	2	1				1								10
y				1			1												2
Types of errors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	155

Table X is read as follows:

Example a contains 2 errors--one in adding instead of multiplying (6) and one in subtracting instead of multiplying (18)

Since the I.Q's varied so much in this class it might be well to explain certain things about several of the pupils. Mary, with an I.Q. of 67, came to us from another district in the city. Her record of attendance was very poor. She had no mother. Her father was on the welfare. They made their home with her young married brother. When Mary came to us she could not add the simplest combinations. Before the 5 P multiplication was given she had received some individual help but not very much.

Her progress might have been discouraging to any but an understanding teacher. Her gains were slow but somewhat steady. On her first re-test, at the end of 45 twenty-minute periods, of teaching, most of which were given to individual instruction, she raised her score from 28--time 27 min.--to 68--time 19 min. On the second retest, following 6 twenty-minute periods of remedial work, her score dropped to 60--time 24 min. On her third re-test with 6 more periods of remedial work her score went up to 88--time 18 min. This was considered a triumph by her teacher, by the cadet teacher who also helped her, and by the writer. At the end of two more periods of twenty minutes each her score reached the 100 % mark--time 40 min. She had learned to check; this doubled her time.

Mary received 59 twenty-minute periods of remedial instruction--a total of 1180 minutes or 19 hours and 40 min-

utes. About half of the time was spent in individual instruction. The rest of the time she worked with Group 3.

Let us compare her record with that of Frances who had an I.Q. of 145 according to the National Intelligence Test. Frances was 9 years and 5 months of age when she took the test on Nov. 5, 1935. Her score was 92 and her time was 25 minutes. On the first re-test, after 10 twenty-minute periods of remedial work, she received a score of 88--time 15 minutes. She gained 10 minutes in time but lost 4 points on her score.

On the second re-test she received a score of 88, the same as on the first re-test, but shortened her time to 13 minutes, with an added 2 twenty-minute periods of remedial work. After 5 more twenty-minute periods of instruction she received a score of 96 on the third re-test--time 15 minutes. This was better than on the first test but her time was 2 minutes longer than on the second re-test.

On the fourth re-test, after having received a total of 50 twenty-minute periods of remedial work since Nov. 5, 1935, she received 92--time 12 minutes. She shortened her time but again lowered her score. On the successive re-tests she received scores of 88--time 15 minutes, 96--time 15 minutes, 96--time 15 minutes, and finally a score of 100--time 16 minutes, after having received 24 more twenty-minute periods of remedial work.

Frances 9 yr. 5 mo.--I.Q. 145--74 periods--1480 min. --24 hr. 40 min.

Mary 14 yr. 2 mo.--I.Q. 67--59 periods--1180 min.-19 hr. 40 min.

The two most extreme cases in the class have been cited here. It isn't quite possible to make a comparison as these girls have very different backgrounds and come from very different environments. Yet Mary's progress was one of the high lights of the year.

Another pupil in Group 3 deserves some mention. Geneva was 12 years and 1 month of age when she took the test on Nov. 5. Her score was 72 and her time 27 minutes. Her I.Q., based on the National Intelligence Test was 86. The Binet test given last year gave her an I.Q. of 79. She reached her record of 100 % accuracy after having received 45 twenty-minute periods of remedial work or a total of 900 minutes equalling 15 hours.

Geneva is the type of pupil, who, if given time enough, can learn on a drill basis. Her record was very good in comparison with other members of the class. There were 6 pupils with higher I.Q.'s who received fewer periods of remedial work than she; there were eight others who received the same number of periods of remedial work, which was 45; and there were 21 who received more periods of remedial work than she.

Josephine and Catherine are twins. Josephine has an I.Q. of 87 and Catherine an I.Q. of 78 according to the National Intelligence Test. Both of these girls were retarded in the

fourth grade before they came to our building. They are of Italian parentage and have had the handicap of language to overcome. They were 11 years and 2 months of age when the test was given on Nov. 5, 1935. Josephine received a score of 100--time 20 min. She was one of two pupils in the class to receive a score of 100, on the first test. Catherine received a score of 92--time 19 minutes. After 50 twenty-minute periods of remedial work Catherine received her perfect score. She was re-tested 4 times.

Josephine--age 11-2 I.Q.87 100--23 min.

Catherine--age 11-2 I.Q.78 92--19 min. 50 per. 1000 min.
16 hr. 40 min.

For convenience in handling the pupils either for group work or individual instruction the thirty-six pupils not receiving perfect scores on the initial test were divided into three groups. The first group consisted of the pupils receiving scores of 96 and 92. The second group was made up of pupils receiving scores of 88, 84, and 80. The third group consisted of the pupils receiving scores of 76, 72, 68, 64, and 28.

On the first re-test in Group 1 one pupil received a perfect score after 10 twenty-minute periods of remedial work; in Group 2 no one received a perfect score; in Group 3 three pupils received perfect scores after 45 twenty-minute periods of instruction. On the second re-test in Group 1 three pupils received perfect scores after 2 more twenty-

minute periods of help. In Group 2 five pupils received perfect scores after 45 twenty-minute periods of remedial work; and in Group 3 one pupil received a perfect score after 51 twenty-minute periods of instruction.

On the third re-test in Group 1 one pupil received a perfect score; in Group 2 one pupil received a perfect score after 60 twenty-minute periods of help; and in Group 3 no one received a perfect score. On the fourth re-test in Group 1 one pupil received a perfect score; in Group 2 no one received a perfect score; and in Group 3 three pupils received perfect scores.

On the fifth re-test in Group 1 three received perfect scores after 51 twenty-minute periods of instruction and one pupil received a perfect score after 50 twenty-minute periods of help; in Group 2 one received a perfect score after receiving help for 68 twenty-minute periods; and in Group 3 no one received a perfect score. On the sixth re-test in Group 1 two pupils received perfect scores with a total of 66 twenty-minute periods; in Group 2 two pupils received perfect scores with a total of 72 twenty-minute periods; and in Group 3 the last three pupils in the group received perfect scores with a total of 59 twenty-minute periods of remedial work.

On the seventh re-test no one in either the first or second group received perfect scores. On the eighth re-test one pupil in Group 1 received a perfect score after a total

of 74 twenty-minute periods of remedial work; and in Group 2 two pupils received perfect scores, one after having received 74 twenty-minute periods of help and the other after having received 44 twenty-minute of remedial work.

1742 twenty-minute periods equalling 580 hours and 40 minutes were used in this remedial work with 36 pupils. The "tables" habit is a very tenacious one. This probably accounts for the length of time it took to attain perfect scores. Most of these fifth grade pupils were taught the "tables" through the 6's in the third grade and the remaining "tables" through the 12's in the fourth grade.

It was a joy to work with these children. As each pupil received a perfect score he or she dropped out of the drill group. They were commended for their achievement and those who remained in the group were encouraged to try to do better the next time. At no time was coercion used. This was done as extra work. Many times children came in early for extra help and many remained voluntarily for more work after the others had gone home. A definite record was kept of all instruction periods, whether individual or group work, and these results are assembled in Table XI which follows:

Table XI

Showing the scores made and the time used in taking the first test and the total time allotted to Remedial work with 38 fifth grade pupils between Nov. 5, 1936 and June 23, 1936.

	Nov. 5, 1935		First Re-test Dec. 17, 1935				Second Re-test Dec.20,1935			Third Re-test Jan.10,1936			Fourth Re-test Jan.17,1936			Fifth Re-test Apr.1,1936			Sixth Re-test May 19,1936			Seventh Re-test June 3, 1936			Eighth Re-test June 11, 1936			June 19, 1936			June 22, 1936		June 23, 1936	
	Age	I.Q. M.I.T.	Score	Time	Score	Time	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods
1 Beatrice	10- 0	133	100	23																														
2 Josephine	11- 2	87	100	20																														
3 Dorothy B.	11- 8	87	96	22	96	23	10	100	28	2																								
4 Esther	12- 5	89	96	40	88	22	10	92	29	2	88	20	5	88	19	4	100	25	30															
5 Alfred	10-10	105	96	30	96	22	10	92	19	2	96	20	5	100	19	4																		
6 Rose T.	10- 2	121	92	19	92	23	10	100	27	2																								
7 Anna C.	10- 5	111	92	22	88	15	10	92	14	2	96	16	5	92	13	4	100	11	30															
8 Lenora	9- 9	121	92	20	92	19	10	100	18	2																								
9 Ruth S.	10- 3	115	92	18	100	19	10													100	22	15												
10 Rita	11- 3	101	92	23	88	21	10	92	16	2	92	19	5	92	17	4	96	16	30															
11 Eric	10- 0	132	92	23	84	22	10	80	17	2	100	16	5							88	15	15	96	15	6	100	16	3						
12 Frances	9- 5	145	92	25	88	15	10	88	13	2	96	15	5	Ab.		3	92	12	30	100	13	15												
13 Salvatore	10- 3	105	92	23	68	14	10	84	14	2	88	15	5	92	10	4	94	15	30															
14 Hazel	10- 9	106	92	18	88	15	10	92	13	2	96	16	5	96	11	4	100	17	30															
15 Catherine	11- 2	79	92	19	92	17	10	96	14	2	96	16	5	Ab.		3	100	16	30															
								Begun Dec. 1, 1935			First Re-test						Second Re-test			Third Re-test			Fourth Re-test			Fifth Re-test			Sixth Re-test			Seventh Re-test			Eighth Re-test		
16 Ethel	10- 4	110	88	25							88	14	15				100	12	30															
17 Elinor	9- 0	107	88	19							96	14	15				100	16	30															
18 Joseph	10- 5	115	88	27							88	19	15				100	16	30															
19 Fred	10- 3	116	88	27							80	13	15				Absent			88	7	15	96	11	6	92	14	3	92	16	3	96	10	1	100	20	1
20 Barbara	9-11	114	84	18							96	25	15				100	10	30															
21 Mary G.	10- 5	113	84	19							96	12	15				92	12	30	80	11	15	84	14	6	88	12	3	100	22	3			
22 John F.	11- 3	105	84	22							64	14	15				96	13	30	76	16	15	84	15	6	92	12	3	100	10	3			
23 Jack	11- 1	104	84	29							Ab.		10				Ab.		20	100	21	15												
24 Rose C.	11- 3	100	84	24							88	21	15				96	27	30	100	22	15												
25 Lillian	10- 9	133	80	13							84	23	15				100	17	30															
26 Everett	10- 9	133	80	24							68	18	15				96	13	30	80	14	15	88	13	6	92	12	3	92	10	3			
27 Gerald	12- 7	83	80	13							92	9	15				96	10	30	96	7	15	96	10	6	100	15	3				96	10	1
28 Robert S.	10-11	93	80	19							96	13	15				Ab.		25	100	16	15										100	8	1

Table XI

Showing the scores made and the time used in taking the first test and the total time allotted to remedial work with 38 fifth grade pupils between Nov. 5, 1935 and June 23, 1936.

	Nov. 5, 1935				First Re-test May 19, 1936			Second Re-test June 3,1936			Third Re-test June 11, 1936			Fourth Re-test June 19, 1936			Fifth Re-test June 22, 1936			Sixth Re-test June 23, 1936		
	Age	I.Q. N.I.T.	Score	Time	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No.of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods
29 Beatrice H.	12- 3	99	76	19	100	8	45															
30 John D.	10- 0	113	76	19	96	18	45	100	18	6												
31 Douglas	10- 8	118	76	18	96	7	45	92	10	6	80	12	3	92	8	3	88	18	1	100	20	1
32 Peggy	9- 3	131	72	34	92	21	45	88	21	6	92	20	3	100	23	3	--	--	-	--	--	-
33 Alice	11- 8	100	72	32	96	12	45	88	12	6	96	21	3	100	21	3	--	--	-	--	--	-
34 Dorothy M.	11- 8	107	72	23	100	14	45	--	--	-	--	--	-	--	--	-	--	--	-	--	--	-
35 Geneva	12- 1	86	72	27	100	19	45	--		-	--	--	-	--	--	-	--	--	-	--	--	-
36 Florence	11- 5	108	68	19	84	15	45	72	13	6	92	20	3	92	25	3	84	16	1	100	25	1
37 Thomas	10- 5	122	64	18	84	7	45	96	11	6	92	12	3	100	8	3	--	--	-	--	--	-
38 Mary R.	14- 2	67	28	37	68	19	45	60	24	6	Absent		3	88	18	3	88	21	1	100	40	1

Table XII

Showing a Summary of the scores made and the time used in taking the test first test and the total time allotted to remedial work with 38 fifth grade pupils between Nov. 5, 1935 and June 23, 1936.

	Age	I.Q. N.I.T.	Score	Time	No. of 20 min. periods	Total No. Minutes	Hours) and) Minutes)
1 Beatrice	10- 0	133	100	23			
2 Josephine	11- 2	87	100	20			
3 Dorothy B.	11- 8	87	96	22	10	200	3 20
4 Esther	12- 5	89	96	40	51	1020	17
5 Alfred	10-10	105	96	30	21	420	7
6 Rose	10- 2	121	96	19	12	240	4
7 Anna C.	10- 5	111	92	22	51	1020	17
8 Lenora	9- 9	121	92	20	12	240	4
9 Ruth S.	10- 3	115	92	18	10	200	3 20
10 Rita	11- 3	101	92	23	67	1340	22 20
11 Eric	10- 0	132	92	23	17	340	5 40
12 Frances	9- 5	145	92	25	74	1480	24 40
13 Salvatore	10- 3	105	92	23	66	1320	22
14 Hazel	10- 9	106	92	18	51	1020	17
15 Catherine	11- 2	78	92	19	50	1000	16
16 Ethel	10- 4	110	88	25	45	900	15
17 Elinor	9- 0	107	88	19	45	900	15
18 Joseph	10- 5	115	88	27	45	900	15
19 Fred	10- 3	116	88	18	44	880	14 40
20 Barbara	9-11	114	84	18	45	900	15
21 Mary G.	10- 5	113	84	19	72	1440	24
22 John F.	11- 3	105	84	22	72	1440	24
23 Jack	11- 1	104	84	29	45	900	15
24 Rose C.	11- 3	100	84	24	60	1200	20
25 Lillian	10- 7	115	84	31	45	900	15
26 Everett	10- 9	133	80	24	74	1480	24 40
27 Gerald	12- 7	83	80	13	69	1380	23
28 Robert S.	10-11	93	80	19	55	1100	18

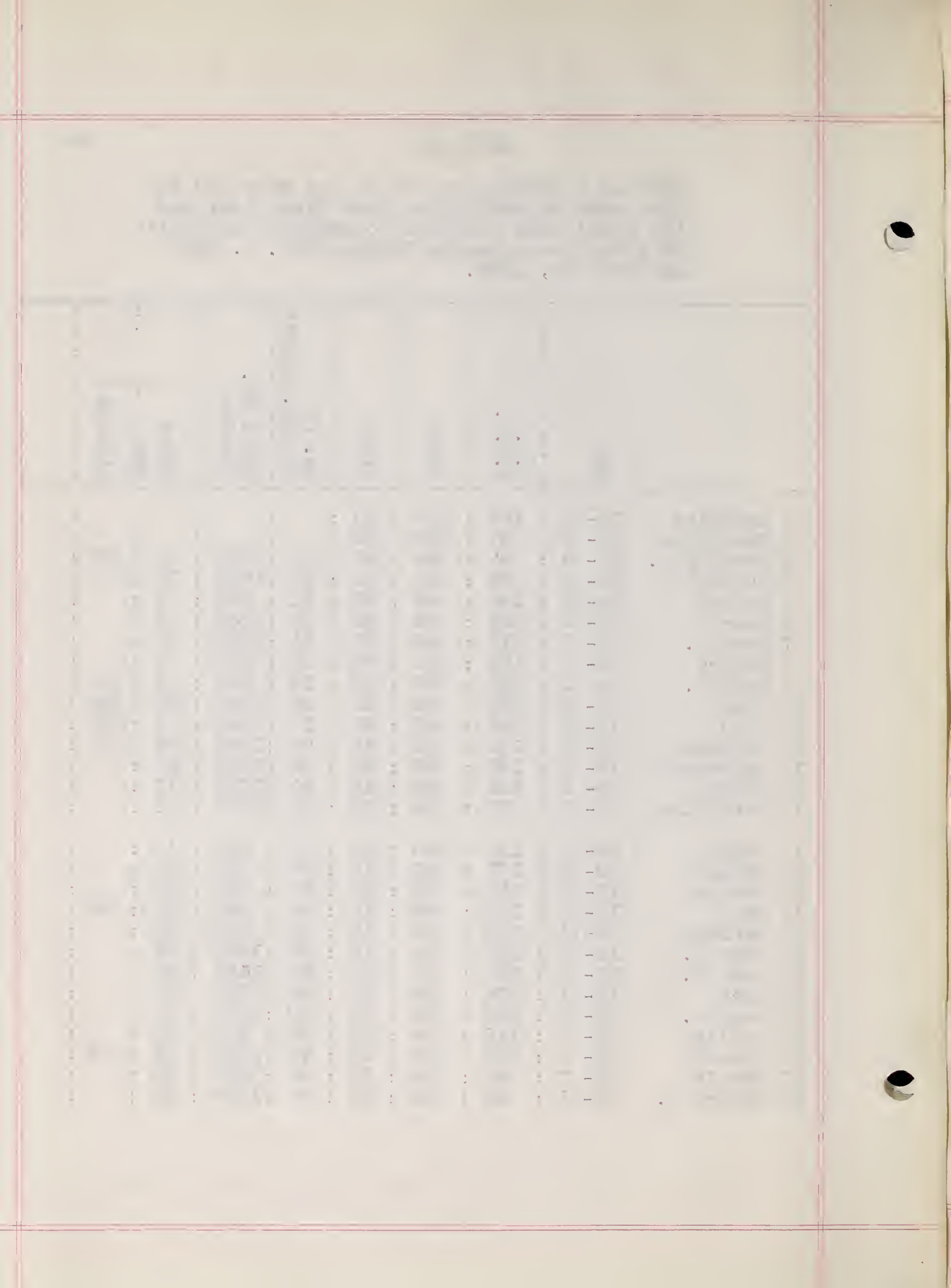


Table XII Continued

	Age	I.Q. N.I.T.	Score	Time	No. of 20 min. periods	Total No. minutes	Hours) and) Minutes)
29 Beatrice H.	12- 8	99	76	19	45	900	15
30 John D.	10- 0	113	76	18	51	1020	17
31 Douglas	10- 8	118	76	18	59	1180	19 40
32 Peggy	9- 3	131	72	34	57	1140	19
33 Alice	11- 8	100	72	32	57	1140	19
34 Dorothy M.	11- 2	107	72	23	45	900	15
35 Geneva	12- 1	86	72	27	45	900	15 40
36 Florence	11- 5	108	68	19	59	1180	19 40
37 Thomas	10- 5	122	64	18	57	1140	19
38 Mary R.	14- 2	67	28	37	59	1180	19 40
		Average			48	940	15 40

An average of 48 twenty-minute periods of remedial work was given to each fifth grade pupil or 15 hr. 40 min.

One of the first skills that the fifth grade has to develop is the skill of checking. This is taught in our own fourth grades, but a full class of fifth grade pupils comes to us in September from another district. These pupils may or may not have been required to check in the fourth grade. All of the time recorded includes checking as stated earlier in the study. All of these pupils were taught the multiplication combinations by the "tables" method. So the writer feels, very conclusively, that when the time was long, counting or "saying the tables" resulted. Increase in time means a very definite form of remedial instruction to change this particular habit of work.

The remedial work was carried on by a very competent room teacher for the most part. Some of the work with Group 3 was carried on by a cadet teacher under the direction of the regular room teacher. All of the testing was done by the writer and occasionally some of the remedial work also.

The first step in the remedial work was to find out in which combinations each pupil was weak. Drill was given on these combinations after they were first taught by groups according to the Wilson Drill service. Then the steps were taken in the order of difficulty. Each pupil moved to the next step or to the next group just as fast as the work was accomplished with perfect mastery.

The set up of the Wilson Drill Service is explained in the foreword to the pupil:

"Multiplication has been a favorite process. The number of facts needed is small, a total of only one hundred. In business it is the process most used. You will want therefore to master multiplication perfectly. Results less than 100% are not satisfactory.

The general plan in this book is to divide the facts into small groups. There are ten groups. You master the facts of the group and then you learn to use the facts in bigger examples. As a result, when you have worked all the examples in this drill book you should know multiplication perfectly. It is not a difficult process. It uses addition and so gives you a good review of previous work in addition.

You will want to learn each fact so well that you know it standing alone whenever you meet it. There will be opportunities for checking yourself, thus giving you a chance to see how well you are getting along. You will enjoy the game of multiplication. Every child can win." (48)

In the Wilson Drill Service the 100 multiplication combinations are divided into ten groups. Each group is made up of ten facts which are really five facts and their reversals. Each group is divided into ten steps proceeding according to difficulty. The first steps contain the easier processes in multiplication and proceed through the ten steps with the processes becoming more difficult.

One group--Group 1--with the ten steps of difficulty of the Wilson Drill Service follows in Table XIII.

Table XIII

From the Wilson Drill Service

Group I--MULTIPLICATION (48)

Steps 1 and 2. Primary Facts.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
7	3	7	1	5	0	2	5	2	2
0	3	5	2	2	7	2	7	1	5
0	9	35	2	10	0	4	35	2	10

All of the work in Group 1 will involve only the combinations used in Group 1

Multiply:

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
1	7	2	7	5	0	2	3	(1)
2	5	5	0	2	7	5	3	
5	0	3	2	5	2	7	7	(2)
2	7	3	2	7	1	0	0	
7	7	2	3	1	0	2	5	(3)
0	5	1	3	2	7	2	7	
2	1	5	5	2	7	3	2	(4)
2	2	7	2	1	5	3	5	

Step 3--One-Place Multiplier, No Carrying

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
1 1	1 1 1	2 2	$2.2 2	1 2	2 1	1 2 2	2 1 2
2	2	2	2	2	2	2	2

(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
2 2 1	$1.1 2	1 2 1	2 1 1	3 3	$3.3 3	2 2	2 2 2
2	2	2	2	2	2	2	2

Step 4. One-Place Multiplier, Carrying Requiring Addition in same Decade

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
5 5	$5.5 5	7 7	7 7 7	2 2	$2.2 2	7 2	$.2 7
7	7	5	5	5	5	5	5

(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
7 7 2	7 2 7	7 7 2	7 2 2	2 7 2	2 2 7	5 5	$5.5 5
5	5	5	5	5	5	2	2

Step 5 One-Place Multiplier, Carrying Requiring Addition into Higher Decade

Because the multipliers in Group 1 are all small there are no examples under Step 5. You will have no practice on Step 5, therefore, until you reach Step 5 of Group 11.

Step 6. One-Place Multiplier, Zero in Multiplicand, with and Carrying to the Zero

(a)	(b)	(c)	(d)
$. 5 0	5 0 5	5 0 5 5	$5 5 . 0 5
7	7	7	7

Step 7. Two- or Three-Place Multiplier, No Carrying

(a)	(b)	(c)	(d)	(e)	(f)	(g)
1 1	1 1 1	2 2	$2.2 2	1 2	2 1	1 2 2
2 2	2 2 2	2 2	2 2 2	2 2	2 2	2 2 2

(h)	(i)	(j)	(k)	(l)	(m)	(n)
2 1 2	$2.2 1	1 1 2	1 2 1	2 1 1	$.3 3	3 3 3
2 2	2 2	2 2	2 2	2 2 2	3 3	3 3 3

(o)	(p)	(q)	(r)	(s)	(t)	(u)
2 2	2 2 2	2 2	2 2	2 2 2	2 2 2	1 1 2
1 1	1 1 1	1 2	2 1	1 2 2	1 2 1	2 2

Step 8. Two- or Three-Place Multiplier, with Carrying

(a)	(b)	(c)	(d)	(e)	(f)	(g)
5 5	5 5 5	$.7 7	7 7 7	2 2	$2.2 2	2 7
7 7	7 7 7	5 5	5 5 5	5 5	5 5 5	5 5

(h)	(i)	(j)	(k)	(l)	(m)	(n)
7 2	2 2 7	2 7 2	7 2 2	2 7 7	7 2 7	7 7 2
5 5	5 5	5 5	5 5	5 5	5 5 5	5 5

(o)	(p)	(q)	(r)	(s)	(t)	(u)
5 5	5 5 5	2 5	$2.5 5	5 2 5	5 5 2	2 5 2
2 2	2 2 2	2 2	2 2	2 2	2 2 2	2 2

Table XIII Cont.

Step 9. Single Zero in the Multiplier

(a)	(b)	(c)	(d)	(e)
7 7	$7.7 7	7 7	7 7 7	$7.7 7
5 0	5 0	5 0 5	5 0 5 5	5 5 0 5

Step 10. Double Zeros in the Multiplicand and Multiplier

(a)	(b)	(c)	(d)
5 0 0	5 0 0 5	7 7 7	7 7 7
7 7	7 7 7	5 0 0	5 0 0 5

Drill was given very specifically on the multiplication combinations that were weak. Almost every error can be traced to its relative position in the Drill Service by finding the group and the step in that particular group that carries the difficulty encountered by the pupil. Then drill is given in that step of that particular group.

A great deal of flash card drill is used for automatic response. Each card contains one of the one hundred multiplication combinations. On the reverse side of the card is the same combination with the answer. If a pupil hesitates on a combination he is given the card where he may study the particular combination on which he failed.

Games with flash cards may be introduced. The pupil wins the game who has no cards in his hands at the end of the drill. Some times all in the group are winners and that causes fun. At odd moments during the day, or in out of school hours the children like to help each other with the flash card drill on the combinations. Several groups of two, one flashing the cards and one answering, may have a race. The group finishing first becomes the winner.

Appendix B contains the 100 multiplication combinations used in flash card drill.

Another type of flash card drill is the kind that contains the multiplication combination and the carrying figure such as 6 X 5 + 4. This type of drill is in Appendix C.

Chapter VI

Specific Remedial Work in Grade Six and the Results

The story of specific remedial work in the sixth grade will be of interest. The work was carried on in a similar manner to the work done in the fifth grade. The 5 P Multiplication Test was given in the sixth grade on April 3, 1936. There were 38 pupils in this class also. Their ages ranged from 10-7 to 12-11. I.Q.'s ranged from 92 (low) to 138 (high).

The lowest score was 80 and the highest 100. Eleven pupils received perfect scores. The shortest time was ten minutes and the longest time was twenty-seven minutes. The data on scores and time follows on page 46 Table XIV. The same data is shown graphically on pages 47 and 48 Figures 4 and 5.

Table XIV

Showing the Scores made on the 5 P Multiplication Test by 38 Sixth Grade Pupils, April 3, 1936

No. of pupils	Score	
11	100	Q_3 100
9	96	Median 96
10	92	Q_1 92
4	88	
2	84	
2	80	
38		

Standard Deviation 6.05

The Time taken by 38 pupils in the Sixth Grade on the 5 P Multiplication Test is indicated below:

No. of pupils	Time	
3	10	
6	11	
2	12	Q_3 12
10	13	Median 13
3	14	
1	15	
1	16	
3	17	
2	18	Q_1 18
2	19	
1	20	
2	23	
2	27	
38		

Figure 4

Showing graphically the distribution of scores on the 5 P Multiplication Test made by 38 Sixth Grade Pupils April 3, 1936

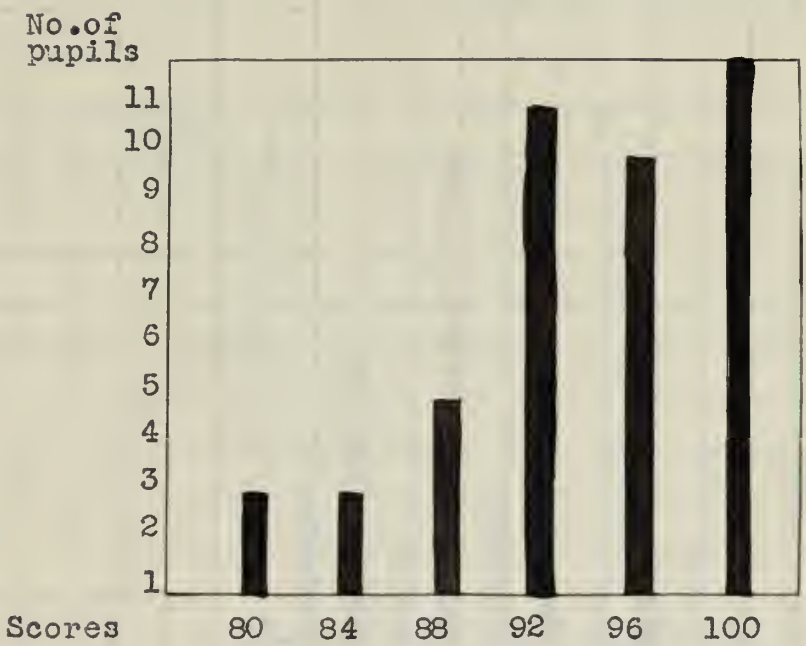


Figure 4 is read as follows:
11 pupils received a score of 100

Figure 5

Showing graphically the distribution of time in the 5 P Multiplication Test made by 38 Sixth Grade Pupils

April 3, 1936

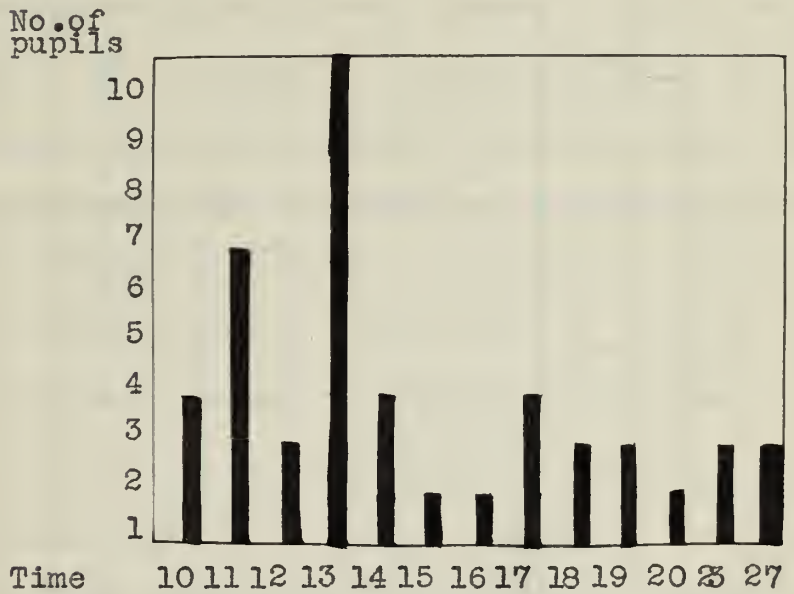


Figure 5 is read as follows:

3 pupils completed the test in 10 minutes.

All time included checking.

Thirteen types of errors were found in the 5 P Multiplication test taken by the 38 sixth grade pupils on April 3, 1936. This was a gain on 5 over the number of types of errors when the test was given to 38 fifth grade pupils Nov. 5, 1935.

"Carrying in Multiplication" remains at the head of the list of errors with 13--22.01 %. Second on the list is "Product in the wrong place--10 errors--17.01 %; third "added instead of multiplying"--6 errors--10.16 %; fourth "dollars and cents times 10" ($5.90 X 10)--6 errors--10.16 %; fifth "multiplied wrong--no carrying"--5 errors--8.47 %; sixth "error in adding the partial products"--4 errors--6.61 %; seventh "digit times zero"--4 errors--6.61 %; eighth "multiplied instead of adding"--3 errors--5.08 %; ninth "omitted one product"--2 errors--3.38 %; tenth "omitted decimal point"--2 errors--3.38 %; eleventh "omitted a figure in the multiplicand"-2 errors--3.38 %; twelfth "omitted an example"--1 error--1.69 %; thirteenth "multiplied by the wrong figure"--1 error--1.69%.

The total number of errors was 59.

The above data is shown in Table XV which follows, and is shown graphically in Figure 6 which follows Table XV.

Table XV

Showing the types, number, and percentage of errors in the 5 P Multiplication Test made by 38 Sixth Grade pupils, April 3, 1936.

The types, number, and percentage of errors has decreased in this sixth grade. 13 types of errors were found.

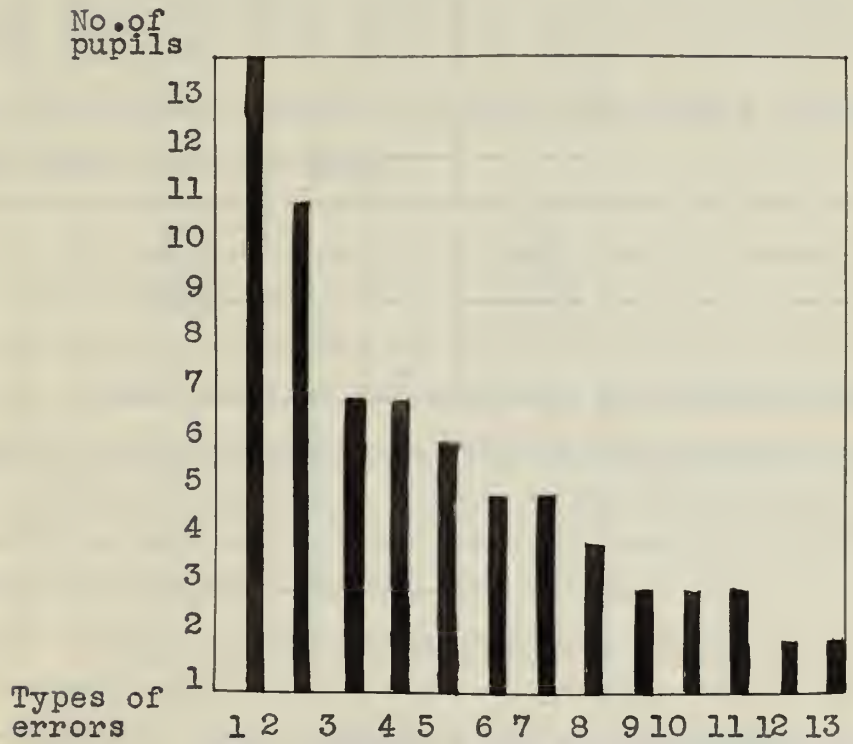
1	Carrying in multiplication	13	22.01 %
2	Product in the wrong place	10	17.01 %
3	Added instead of multiplying	6	10.16 %
4	Dollars and cents times 10	6	10.16 %
5	Multiplied wrong-no carrying	5	8.47 %
6	Error in adding	4	6.61 %
7	Digit times zero	4	6.61 %
8	Multiplied instead of adding	3	5.08 %
9	Omitted one product	2	3.38 %
10	Omitted decimal point	2	3.38 %
11	Omitted a figure in the multiplicand	2	3.38 %
12	Omitted an example	1	1.69 %
13	Multiplied by the wrong figure	1	1.69 %
	Total number of errors	59	

Figure 6

Showing graphically the types of errors in the

5 P Multiplication Test made by 38 Sixth Grade pupils

April 3, 1936



The 13 types of errors appearing at the bottom of the graph are numbered to correspond with the numbers of the types of errors in Table XV.

In Table XVI which follows on page 53 the distribution of the types of errors has been tabulated according to examples. The twenty-five examples are numbered alphabetically from a to y inclusive. In the fifth grade there were 155 errors while in the sixth grade there were 59 errors.

There were 7 errors in example "w." This example seemed to be the most difficult one in the test or rather the one on which the most errors were made. In example "r" there were 5 errors made.

(w)	(r)
784	54
367	270

Four of the seven errors in example w were in carrying in multiplication, and the five errors in example "r" were made in placing the last product in the wrong place on account of the zero in the multiplier.

Six pupils did example g incorrectly.

(g)
$5.90
10

The confusion lay in the zero in the multiplicand and the zero in the multiplier.

In example "e" four errors were made in multiplying the digit times the zero. The other errors were fewer in number.

Table XVI

Showing the Distribution of the Types of Errors by Examples in the 5 P Multiplication Test made by 38 Sixth Grade Pupils, April 3, 1936

Ex.	1	2	3	4	5	6	7	8	9	10	11	12	13	
a														
b														
c														
d					1									1
e							4							4
f										2		1		3
g				6										6
h														
i								1						1
j			1											1
k	2					1		1						4
l	2					1								3
m														
n					1									1
o	1										1			2
p	1													1
q	1													1
r		5												5
s		1												1
t		1	1			1								3
u								1						1
v		1	1						1					3
w	4		1		1	1								7
x	2		1		1						1		1	6
y		2	1		1				1					5
Types of errors	1	2	3	4	5	6	7	8	9	10	11	12	13	59

Table XVIII is read as follows: example y contains 5 errors -- 2 "product in wrong place" (2); 1 "added instead of multiplying" (3) 1 "multiplied wrong-no carrying" (5); and 1 "omitted one product"(9)

The same type of instruction was followed as in the fifth grade. These pupils were tested on the 100 multiplication combinations and their weaknesses noted. Drill on the weak combinations followed. The steps according to difficulty were taken next and drilled upon. No drill was given on the combinations already mastered.

The Wilson Drill Service was followed as in the fifth grade work. (See pp.40-43) Each child moved at his own rate from one group of multiplication facts to the next as rapidly as perfect scores were secured. Most of the work in this grade was done individually and a record of the time spent in instruction and drill was kept. Flash card drill was given as in the fifth grade. (See pp.45 and46)

The I.Q's of the pupils who received perfect scores ranged from 94 to 127 although the highest I.Q. in the class was 138. There were eleven pupils who received perfect scores on the first test given on April 3, 1936.

Five re-tests were given before every pupil received a perfect score. On the first re-test 3 pupils received perfect scores after 8 twenty-minute periods of remedial work; on the second re-test eleven pupils received perfect scores after eight additional twenty-minute periods of help in multiplication.

On the third re-test seven pupils received perfect scores after having eight more twenty-minute periods of instruction. On the fourth re-test two pupils received perfect

scores after having five more twenty-minute periods of remedial work; and on the fifth re-test four pupils received perfect scores with three additional twenty-minute periods of instruction. 546 twenty-minute periods equalling 180 hours were used in remedial work with 27 pupils. All of the corrective work was done by the regular room teacher and the testing was done by the writer. The children enjoyed the work. It was fun to know that perfect scores were available for every one of them. Achievement brought the joy of accomplishment. The pupils no longer felt satisfied with a score of 96 when they realized that it was possible for them to receive 100 per cent.

A real desire for excellence could be seen in the daily work of these children. It was a great pleasure to work with them.

Tables with scores, time, and time allotted to remedial work follow herewith:

Table XVII

Showing the scores made and the time used in taking the first test and the total time allotted to remedial work with 38 sixth grade pupils between April 3, 1936 and June 19, 1936.

			Apr.3,1936		April 17			May 14			May 28			June 11			June 19		
	Age	I.Q. N.I.T.	Score	Time	Score	Time	No. of 20 min. periods	Score	Time	No. of 20 min. periods	Score	Time	No.of 20 min.periods	Score	Time	No.of 20 min.periods	Score	Time	No.of 20 min.periods
1 Jean	12- 8	102	100	20															
2 Lloyd	11- 5	107	100	14															
3 Andrew	11- 3	127	100	13															
4 Joseph	11- 9	120	100	19															
5 Mildred	11- 5	120	100	25															
6 Leona	12- 0	100	100	18															
7 Christina	11- 7	94	100	13															
8 Barbara	11- 9	109	100	13															
9 Daniel	11- 8	110	100	13															
10 Roland	13- 2	94	100	16															
11 Elaine	12- 0	115	100	11															
12 Maud	12- 1	110	96	17	92	9	8												
12 Frank	12- 9	74	96	17	84	20	8	100	11	8									
13 John	11- 6	107	96	18	96	9	8	92	21	8	96	9	8	96	10	5	100	12	4
14 Walter H.	11-10	116	96	13	92	9	8	100	13	8									
15 Dorothy C.	10-10	100	96	14	92	7	8	100	15	8									
16 Frances	12-2	124	96	11	100	9	8												
17 Virginia	10- 7	126	96	11	88	11	8												
18 Gaitanna	12- 4	92	96	12	92	10	8												
19 Kenneth	11- 4	108	96	19	92	11	8												
20 Robert C.	11- 3	138	92	23	Absent														
21 Walter L.	11- 3	112	92	10	92	7	8	84	7	8	100	13	8						
22 Robert G.	11- 8	120	92	11	88	8	8	100	14	8									
23 Raymond	11-10	134	92	11	92	6	8	96	7	8	100	7	8						
24 Chandler	12- 9	105	92	27	84	7	8	100	12	8									
25 Brenda	11- 8	120	92	23	100	14	8												
26 Norma	11- 6	131	92	13	88	15	8	100	13	8									
27 Herbert	11- 4	126	92	10	88	10	8	100	15	8									
28 Mary Mc.	12- 0	118	92	27	96	8	8	88	9	8	100	9	8						
30 Anthony	11-10	92	92	13	96	8	8	100	13	8									

Table XVII continued

Showing the scores made and the time used in taking the first test and the total time allotted to remedial work with 38 sixth grade pupils between April 3, 1936 and June 19, 1936.

	Age	I.Q. N.I.T.	Apr.3, 1936 Score	Time	Apr.17 Score	Time	No. of 20 min.periods	May 14 Score	Time	No. of 20 min.periods	May 28 Score	Time	No. of 20 min. periods	June 11 Score	Time	No. of 20 min. periods	June 19 Score	Time	No. of 20 min. periods
31 Lawrence	12- 2	117	88	13	92	6	8	100	12	4									
32 Pauline	12- 0	106	88	17	96	7	8	96	20	8	96	23	8	100	27	5			
33 Teresa	11- 7	124	88	12	80	7	8	88	9	8	100	9							
34 Lois	11- 4	108	88	15	76	15	8	96	15	8	92	15		96	19		100	12	4
35 Beatrice	11- 6	128	84	11	100	10	8												
36 Phyllis	11- 2	115	84	14	88	12	8	96	9	8	92	9		96	10		100	10	
37 Paul	12-11	99	80	10	92	9	8	96	9	8	96	9		96	15		100	12	
38 Regina	10- 9	120	80	13	96	11	8	96	21	8	96	9		100	17		100	12	

Table XVIII

Showing a summary of the scores made and the time used in taking the first and the total time allotted to remedial work with 38 sixth grade pupils between April 3, 1936 and June 19, 1936.

	Age	I.Q. 1936 N.I.T. Score	Time	No. of 20 min. periods	No. of minutes	Hours and Minutes
1 Jean Fr.	12- 8	102	100	20		
2 Lloyd	11- 5	107	100	14		
3 Andrew	11- 3	127	100	13		
4 Joseph	11- 9	120	100	19		
5 Mildred	11- 5	120	100	11		
6 Leona	12- 0	100	100	18		
7 Christina	11- 7	94	100	13		
8 Barbara	11- 9	109	100	13		
9 Daniel	11- 8	110	100	13		
10 Roland	13- 2	94	100	16		
11 Elaine	12- 0	115	100	13		
12 Maud	12- 1	110	96	17	16	320	5 - 20
13 Frank	12- 9	74	96	17	33	660	11 - 0
14 John Sch.	11- 6	116	96	18	16	320	5 - 20
15 Walter H.	11-10	116	96	13	24	480	8 - 0
16 Dorothy C.	10-10	100	96	14	24	480	8 - 0
17 Frances	12- 2	124	96	11	8	160	2 - 40
18 Virginia	10- 7	126	96	11	16	320	5 - 20
19 Gaitanna	12- 4	92	96	12	16	320	5 - 20
20 Kenneth	11- 4	108	96	19	16	320	5 - 20
21 Robert C.	11- 3	138	92	23	4	80	1 - 20
22 Walter L.	11- 3	112	92	10	24	480	8 - 0
23 Robert G.	11- 8	120	92	11	16	320	5 - 20
24 Raymond	11-10	134	92	11	24	480	8 - 0
25 Chandler	12- 0	105	92	27	16	320	5 - 20
26 Brenda	11- 8	120	92	23	8	160	2 - 40
27 Norma	11- 5	131	92	13	16	320	5 - 20
28 Herbert	11- 4	126	92	10	16	320	5 - 20
29 Mary Mc.	12- 0	118	92	27	24	480	8 - 0
30 Anthony	11-10	92	92	13	16	320	5 - 20
31 Lawrence	12- 2	117	88	13	24	480	8 - 0
32 Pauline	12- 0	106	88	17	29	580	9 - 40
33 Teresa	11- 7	124	88	12	24	480	8 - 0
34 Lois	11- 4	108	88	15	33	660	1 - 0
35 Beatrice	11- 6	120	84	11	8	160	2 - 40
36 Phyllis	11- 2	115	84	14	33	660	11 - 0
37 Paul	12-11	99	80	10	33	660	11 - 0
38 Regina	10- 9	120	80	13	29	580	9 - 40
			Average		20	400	6 - 40

An average of 20 twenty-minute periods or 6 hr. and 40 minutes was given to each sixth grade pupil for remedial work.

Conclusions

1. The study justifies the challenge and tentative conclusion that every pupil of normal intelligence in the fifth and sixth grades can secure perfect mastery in multiplication if the teaching is satisfactory.

2. Some pupils with I.Q's lower than 90 can secure perfect mastery in multiplication. Sometimes the I.Q. as named by the N.I.T. is lower than 90 because of language handicap yet the pupil is able to learn and retain anything that he is able to understand. Some pupils with an I.Q. lower than 90 are able to learn and retain subject matter that is a tool subject taught on a drill basis.

3. The counting habit or "saying the tables" can be broken up by teaching the multiplication combinations in unrelated groups. The tables appear to be a definite handicap.

4. Automatic response to the multiplication combinations and the higher decade facts in addition used in carrying will eliminate counting and "saying the tables."

5. Automatic response to the multiplication combinations and the higher decade facts used in carrying will develop accuracy and result in perfect mastery in multiplication.

6. The time needed to bring a fifth grade pupil to perfect scores in multiplication is shown in Tables XI and XII. In general a child with an I.Q. of 107, an initial score of 84, can be brought to a perfect score in 48 twenty-minute

periods of corrective work. This is a statement based on medians.

7. The Time needed to bring a sixth grade pupil to perfect scores in multiplication is shown in Tables XVII and XVIII. In general a child with an I.Q. of 112, an initial score of 96 can be brought to a perfect score in 20 twenty-minute periods of corrective work. This is a statement based on medians.

8. The question of maintenance should receive attention. Re-tests should be given to the pupils receiving perfect scores to see if they are able to reach perfect mastery and retain it. This phase of the work is not considered in the present study.

9. The author wishes to add that the above work proceeded with understanding and motivation. It was not meaningless and mechanical. The children readily conceived the goal, accepted it as reasonable, and worked enthusiastically for its attainment.

Bibliography

1. Benezet, L. P. "The Story of an Experiment. The Teaching of Arithmetic." Journal of the N.E.A. Nov. 1935, Dec. 1935, Jan. 1936.

2. Brownell, W.A. and Watson, Brantley "The Comparative Worth of Two Diagnostic Techniques in Arithmetic." Journal of Educational Research. May 1936.

3. Brownell, W.A. "Remedial Cases in Arithmetic." Peabody Journal of Education. Sept. 1929.

4. Brownell, W.A. and Chazal, Charlotte B. "Effects of Premature Drill in Third Grade Arithmetic." Journal of Educational Research. Sept. 1935.

5. Brueckner, L.J."Diagnostic and Remedial Teaching in Arithmetic--A Critique of the Yearbook." Twenty-Ninth Yearbook of the National Society for the Study of Education. 1930.

6. Brueckner and Melby "Diagnostic and Remedial Teaching." Chapter VII. Arithmetic. Houghton Mifflin. 1931.

7. Brueckner, L.J."Diagnostic and Remedial Teaching in Arithmetic. pp. 144-145. Winston Co. 1930.

8. Burge, Lofton V. "Types of Errors and Questionable Habits of Work in Multiplication." Elementary School Journal. Nov. 1931.

9. Buswell, Guy T. "Summary of Arithmetic Investigations." Elementary School Journal. June 1931.

10. Buswell, Guy T. and John, Leonore "Diagnostic Studies in Arithmetic." University of Chicago. 1926.

11. Charles, Fred "A Father Looks at Schools. Should Children Have to Spend Eight Years on Arithmetic?" Parents' Magazine. Oct. 1933.

12. Clemens, P.B. and Neubauer, P.F. "A Supervision Project in Multiplication." Journal of Educational Research. Dec. 1928. pp. 387, 392, 393, 396.

13. Cooke, Dennis "Diagnostic and Remedial Treatment in Arithmetic." Peabody Journal of Education. Nov. 1932.

14. Cooke, Dennis "Diagnostic and Remedial Treatment in Arithmetic." Peabody Journal of Education. Nov. 1933.

15. Dickey, John W. "Much Ado About the Zero." Elementary School Journal. Nov. 1932.

16. Evans, Roy "Remedial Cases in Arithmetic. Case 2." Peabody Journal of Education. Jan. 1930.

17. Gabbert, Mary L. "Remedial Cases in Arithmetic. Case 1." Peabody Journal of Education. Nov. 1932.

18. Greene, C.E. and Buswell, G.T. "Testing, Diagnosis, and Remedial Work in Arithmetic." Twenty-Ninth Yearbook of the National Society for the Study of Education. 1930. pp. 303, 307, 310, 313.

19. Greene, H.A. "Criteria for Remedial Drill in Arithmetic." Fourth Yearbook Dept. Superintendence.

20. Grossnickle, Foster J. "Transfer of Knowledge of Multiplication Facts to their Use in Long Division." Journal of Educational Research. May 1936.

21. Hillegas, M.B. "Diagnosis of Difficulties in Arithmetic." Lippincott. 1928.

22. Judd, C.H. "Psychological Analysis of the Fundamentals of Arithmetic." Supplementary Educational Monographs, No. 32. p. 13. Dept. of Education, University of Chicago. 1929.

23. Kelley, Anna "Teaching Remedial Arithmetic." American School Journal. August 1935.

24. Knight, F.B."Some Considerations of Method." Twenty-Ninth Yearbook of the National Society for the Study of Education. 1930. pp. 224, 263, 264, 266.

25. Knight, F.B. and Ford, E. "Temporary Lapses in Ability and Error in Arithmetic." Elementary School Journal. Oct. 1931.

26. Lazar, Mary "Diagnostic and Remedial Work in Arithmetic Fundamentals for Intermediate Grades." Bureau of Reference, Research, and Statistics. Board of Education, City of New York.

27. Mason, W.M. "Supervision of Drill Work in Arithmetic." Third Yearbook Dept. Elementary School Principals. 1924.

28. Myers, Edna "A Cooperative Study in Arithmetic." Tenth Yearbook Department Elementary School Principals. 1931.

29. Myers, Gary Cleveland "First Steps in Number Work." Grade Teacher. Nov. 1932.

30. Norem, G.B. and Knight, F.B. "The Learning of the One Hundred Multiplication Combinations." Twenty-Ninth Yearbook of the National Society for the Study of Education. 1930.

31. Osborne, Raymond and Gillet, Harry O. "Mental Age is Important Factor in Teaching Arithmetic." The Nations Schools. July 1933.

32. Osburn, W.J. "Corrective Arithmetic." pp. 4-7 Riverside Press. Cambridge, Mass. 1924.

33. Otto, Henry J. "Remedial Instruction in Arithmetic." Elementary School Journal. Oct. 1927.

34. Peet, Harriet and Dearborn, Walter "A Test in Arithmetic for Measuring General Ability of Pupils in the First Six Grades." Twenty-Ninth Yearbook of the National Society for the Study of Education. 1930.

35. Pitcher, Wilimina E. A Play. "Alice in Dozenland." Mathematics Teacher. Dec. 1934.

36. Pucko, R.F. "5 Case Studies of Arithmetic Failure." p. 1 Unpublished Thesis, Boston University School of Education. 1935.

37. Repp, Austin C."Mixed Versus Isolated Drill Organization." Twenty-Ninth Yearbook of the National Society for the Study of Education. 1930.

38. Robinson, Arthur E. "Are We Teaching Arithmetic Effectively," Mathematics Teacher. April 1935.

39. Ruch, G.M. "Relative Difficulty of the One Hundred Multiplication Facts with Special Reference to Textbook Construction." Elementary School Journal. Jan. 1932.

40. Smith, D.E. "History of Mathematics." Ginn. 1925.

41. Stretch, Lorena B. "The Value and Limitations of Drill in Arithmetic." Childhood Education. June 1935.

42. Trousdale, Mattie S. "Remedial Cases in Arithmetic. Case 3." Peabody Journal of Education. March 1930.

43. Washburne, Carleton "One Reason Children Fail in Arithmetic." Progressive Education. March 1932.

44. Wheat, Harry G. "More Ado About the Zero." Elementary School Journal. April 1932. p. 624.

45. Whitson, W.E. "Remedial Cases in Arithmetic. Case 4." Peabody Journal of Arithmetic. May 1930.

46. Wildman, Edward "The Supervision of Drill Work in Arithmetic." Third Yearbook Department Elementary School Principals. 1924.

47. Wilson, F.T. "The Effect of the Form of a Combination in the Learning of Multiplication Tables by Bright and Dull Children." Journal of Educational Psychology. Oct. 1931.

48. Wilson, Guy M. "My Multiplication and Short Division Drill Book." p. iv Macmillan. 1932.

49. Wilson, Guy M. "Teachers' Manual for the Drill Books." p. 13. Macmillan 1933.

50. Wilson, Guy M. "New Standards in Arithmetic." Journal of Educational Research. Dec. 1920.

51. Wilson, Guy M. "One Hundred Per Cent Addition." American Childhood. Nov. 1935.

52. Wilson, Guy M. "Research: Suggested Standards for Summarizing and Reporting Applied to Two Recent Summaries of Studies in Arithmetic." Journal of Educational Research. Nov. 1934.

53. Wilson, Guy M. "The Challenge of One Hundred Per Cent Accuracy in the Fundamentals in Arithmetic." Educational Method. Nov. 1935.

54. Wilson, Guy M. "Tests: Aims, Procedures, and Types." Journal of Educational Research. March 1935.

55. Wilson, Guy M. "What Arithmetic Shall We Teach?" Houghton Mifflin. 1926.

56. Wilson, Guy M. "Why Children Fail in Arithmetic." American Childhood. Oct. 1935.

57. Wilson, Guy M. "Why not 100 per cent Accuracy in Fundamentals." School Executives Magazine. March 1929. p. 294.

58. Wilson, Guy M. "What Research Reveals on Proper Drill Content of Elementary Arithmetic." Mathematics Teacher. December 1935.

59. Wilson and Hoke "How to Measure" Macmillan. 1929.

60. Woody, Clifford "Achievement in Counting by Children in Primary Grades." Childhood Education. March 1931.

61. Woody, Clifford "Arithmetical Backgrounds for Young Children." Journal of Educational Research. Oct. 1931.

Wilson 5 P Multiplication Test

Multiply

(a)
$$\begin{array}{cccccccccc} 8 & 7 & 4 & 2 & 4 & 7 & 3 & 4 & 8 & 6 \\ \underline{6} & \underline{3} & \underline{9} & \underline{7} & \underline{1} & \underline{5} & \underline{3} & \underline{2} & \underline{4} & \underline{7} \end{array}$$

(b) \$3.65 × 6

(c) 501 × 6

(d) \$8.05 × 7

(e)
$$\begin{array}{cccccccccc} 7 & 4 & 0 & 4 & 0 & 3 & 5 & 4 & 8 & 0 \\ \underline{0} & \underline{5} & \underline{8} & \underline{4} & \underline{1} & \underline{4} & \underline{2} & \underline{0} & \underline{9} & \underline{5} \end{array}$$

(f) \$7.40 × 6

(g) \$5.90 × 10

(h) \$700.95 × 4

(i) 70 × 17

(j) 362 × 21

(k) 95 × 47

(l) 92 × 56

(m) 93 × 89

(n) \$7.30 × 29

(o) 896 × 83

(p) 693 × 600

(q) 445 × 308

(r) 54 × 270

(s) 7081 × 509

(t) \$680 × 120

(u) 915 × 504

(v) 506 × 129

(w) 784 × 367

(x) 8302 × 805

(y) 842 × 2100

Represents the 100 Multiplication Combinations, used in

FLASH CARD DRILL

0 X 7	7 X 0	3 X 3	2 X 2
5 X 7	7 X 5	2 X 1	1 X 2
2 X 5	5 X 2	5 X 0	0 X 5
9 X 5	5 X 9	9 X 7	7 X 9
1 X 7	7 X 1	2 X 6	6 X 2
4 X 4	0 X 0	7 X 8	8 X 7
4 X 5	5 X 4	1 X 8	8 X 1
8 X 2	2 X 8	0 X 4	4 X 0
6 X 9	9 X 6	4 X 3	3 X 4
9 X 1	1 X 9	1 X 3	3 X 1
3 X 0	0 X 3	7 X 7	9 X 9
1 X 6	6 X 1	4 X 9	9 X 8
6 X 3	3 X 6	2 X 0	0 X 2
4 X 8	8 X 4	2 X 7	7 X 2
1 X 4	4 X 1	4 X 9	9 X 4
6 X 0	0 X 6	4 X 7	7 X 4
8 X 3	3 X 8	4 X 2	2 X 4
6 X 6	5 X 5	0 X 8	8 X 0
2 X 3	3 X 2	6 X 4	4 X 6
3 X 5	5 X 3	7 X 6	6 X 7
0 X 9	9 X 0	8 X 6	6 X 8
2 X 9	9 X 2	5 X 1	1 X 5
5 X 8	8 X 5	0 X 1	1 X 0
6 X 5	5 X 6	7 X 3	3 X 7
8 X 8	1 X 1	3 X 9	9 X 3

Multiplication Combinations plus the carrying figure used in

FLASH CARD DRILL

6 X 6 + 3	6 X 3 + 3	6 X 7 + 2
4 X 9 + 2	2 X 3 + 1	7 X 9 + 3
4 X 9 + 3	6 X 9 + 1	5 X 9 + 1
9 X 9 + 2	8 X 9 + 2	9 X 7 + 2
3 X 9 + 1	3 X 8 + 2	8 X 9 + 4
8 X 8 + 7	8 X 4 + 4	8 X 4 + 3
3 X 4 + 1	7 X 5 + 2	2 X 6 + 1
7 X 8 + 2	7 X 7 + 5	6 X 8 + 2
6 X 7 + 5	3 X 8 + 1	3 X 7 + 2
5 X 8 + 1	8 X 8 + 2	7 X 9 + 2
9 X 5 + 2	9 X 7 + 3	8 X 3 + 2
4 X 3 + 1	9 X 4 + 3	8 X 7 + 1
9 X 6 + 1	7 X 6 + 5	3 X 6 + 2
9 X 7 + 4	4 X 8 + 3	6 X 2 + 1
7 X 6 + 2	4 X 3 + 2	7 X 3 + 2
8 X 4 + 5	6 X 5 + 2	4 X 6 + 3
5 X 7 + 4	7 X 9 + 4	4 X 7 + 3
6 X 4 + 5	8 X 3 + 6	5 X 6 + 3
4 X 4 + 3	5 X 9 + 4	6 X 9 + 4
3 X 4 + 2	8 X 4 + 7	6 X 9 + 2
6 X 5 + 5	4 X 8 + 1	8 X 7 + 6
9 X 3 + 3	4 X 3 + 3	7 X 6 + 3
8 X 7 + 2	4 X 8 + 2	5 X 6 + 4